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Tsuzuki et al.

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(54) **DISTANCE SENSOR FOR VEHICLE WITH ELECTRICAL CONNECTOR**

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Primary Examiner — Daniel Pihulic

(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
G01S 3/80 (2006.01)
G12B 9/00 (2006.01)

(57) **ABSTRACT**

(52) **U.S. Cl.** **367/188**; 367/140
(58) **Field of Classification Search** 367/188,
367/173, 165, 140, 118; 73/661, 632; 340/435;
248/27.3

A distance sensor equipped with a mount for mounting the sensor in a mount hole of a bumper of a vehicle. The mount includes a casing with a sensor holder, a bezel, and a resin-made retainer. The bezel is made up of a cylindrical member joined to the sensor holder and a flange having an outer diameter greater than an inner diameter of the mount hole. The retainer includes an annular base joined to the bezel, a plurality of arms, and a plurality of protrusions. The protrusions extend from ends of the arms radially outward of the base and serve to establish a snap-fit on a peripheral edge of the mount hole, thereby nipping a wall of the bumper between the protrusions and the flange tightly to secure the distance sensor to the bumper.

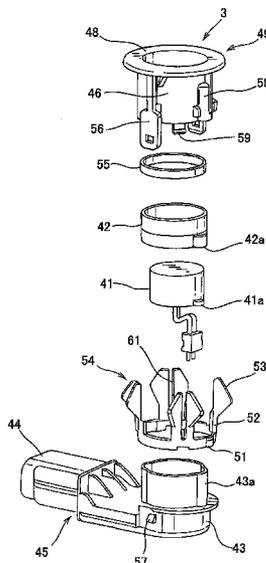
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7 Claims, 12 Drawing Sheets



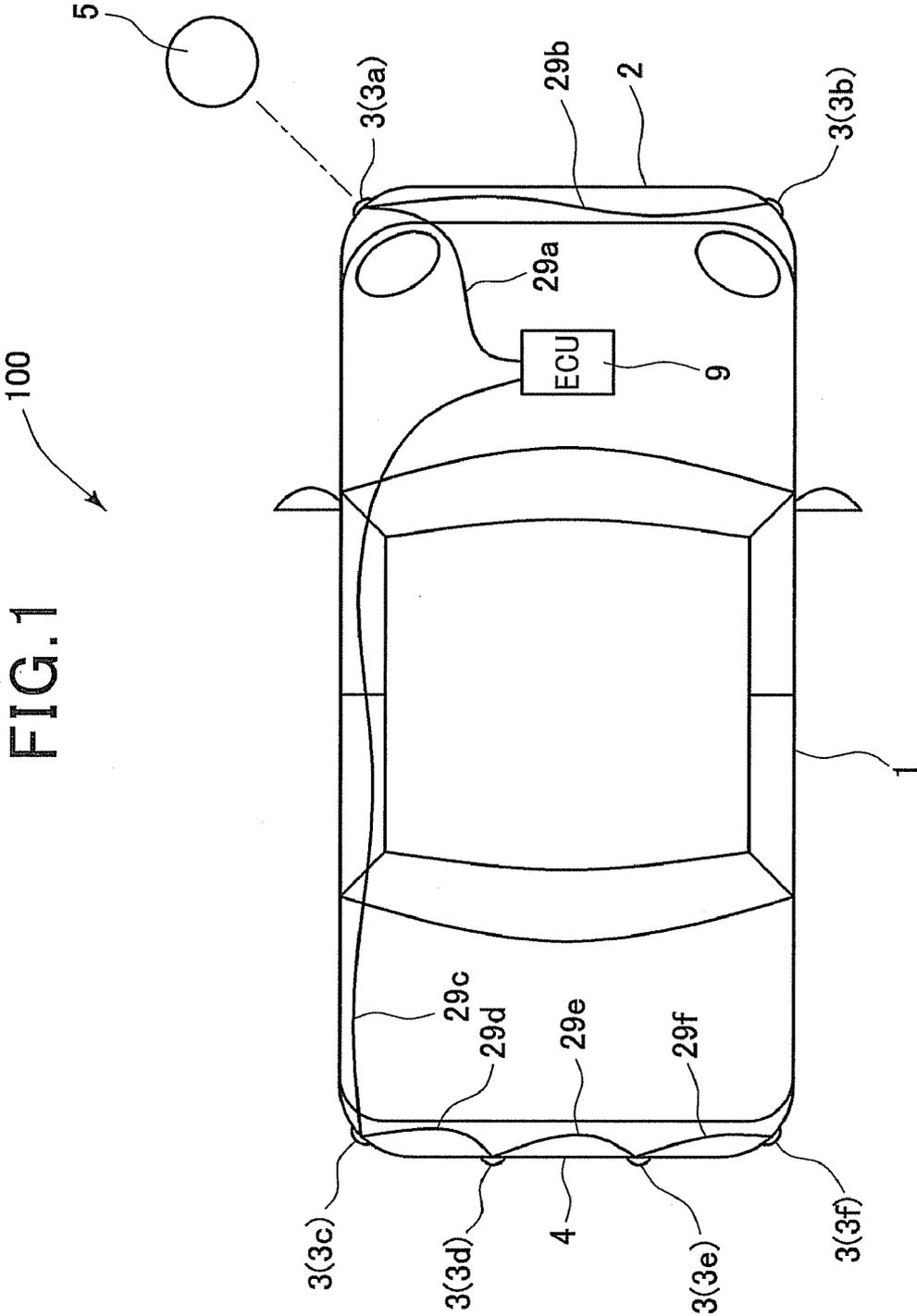


FIG. 4

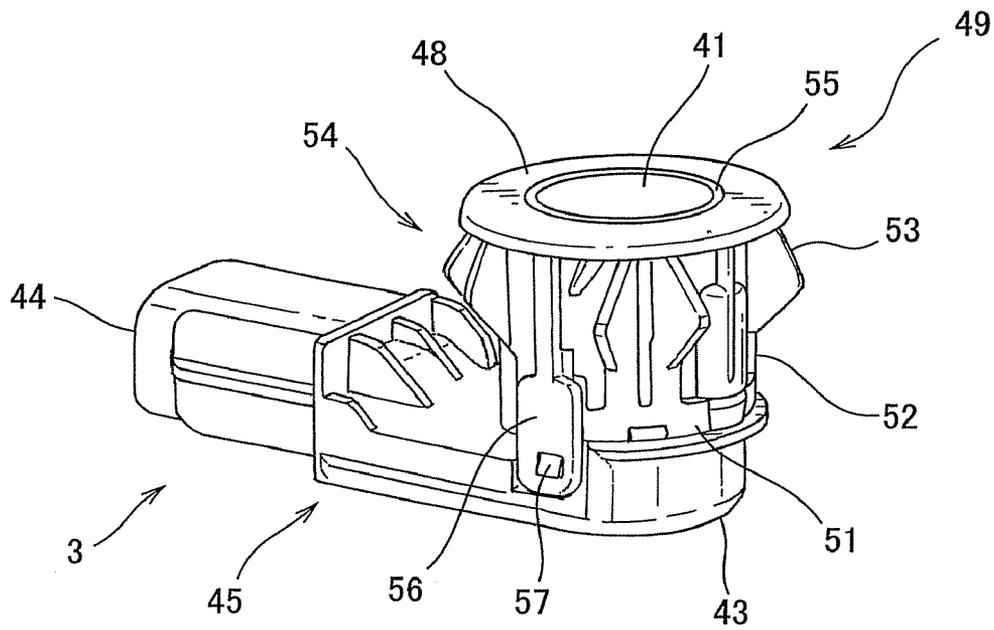


FIG. 5

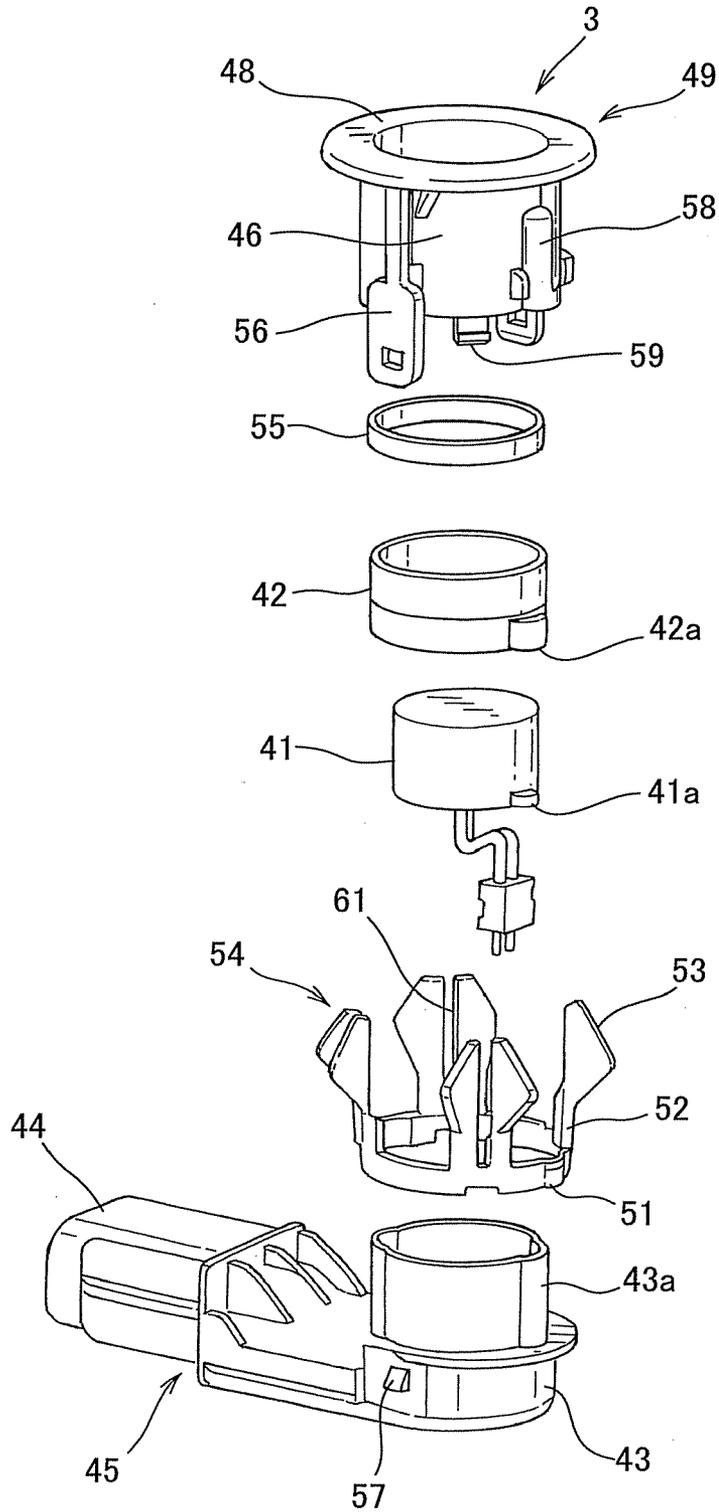


FIG. 6(a)

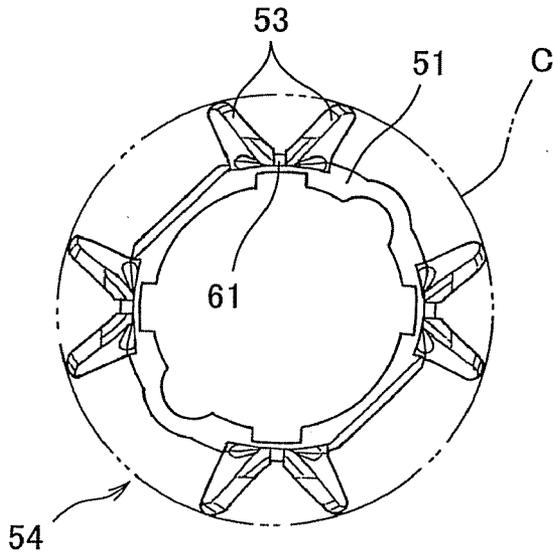


FIG. 6(b)

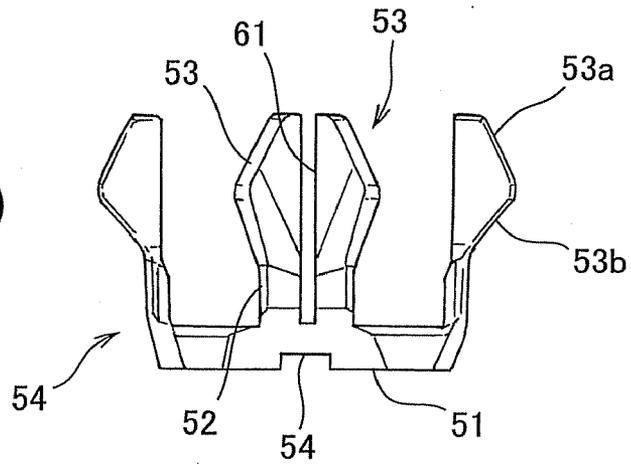


FIG. 6(c)

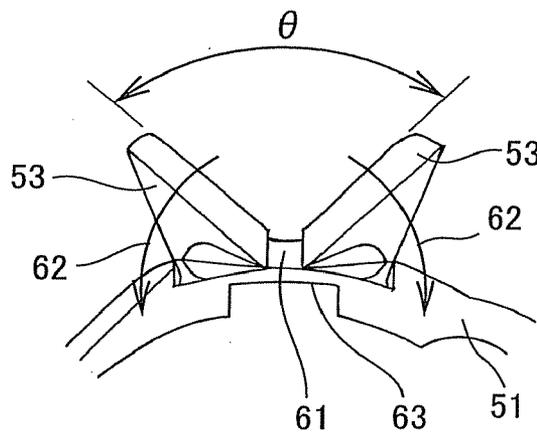


FIG. 7(a)

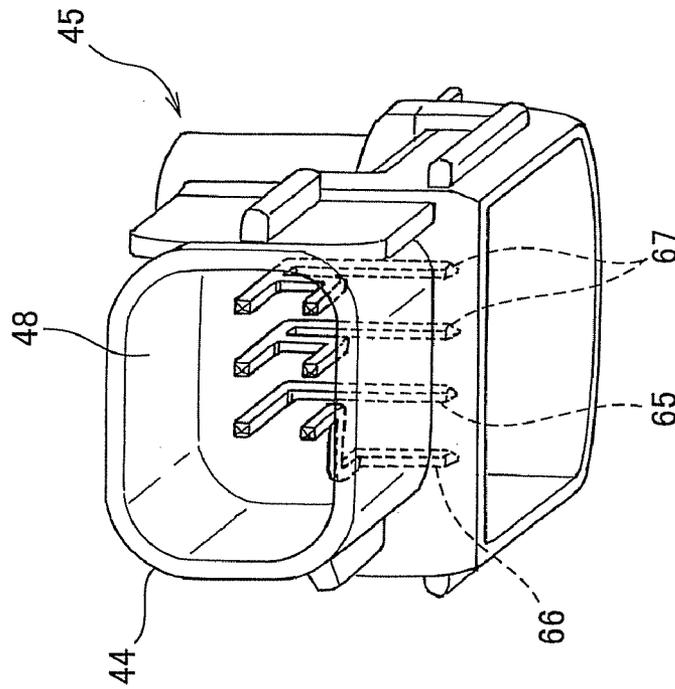


FIG. 7(b)

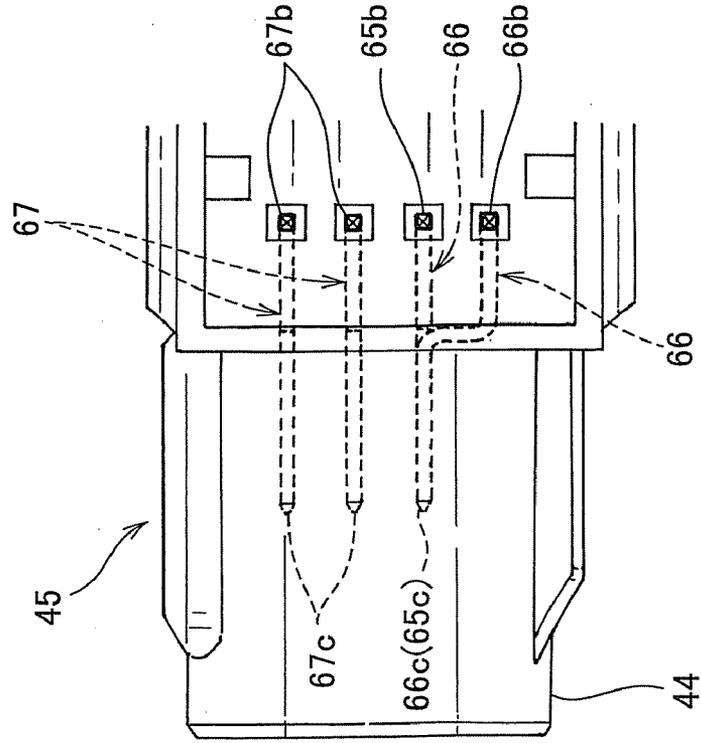


FIG.8(a)

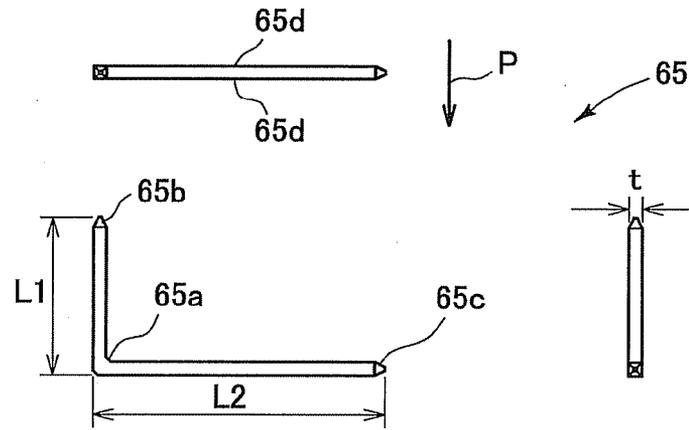


FIG.8(b)

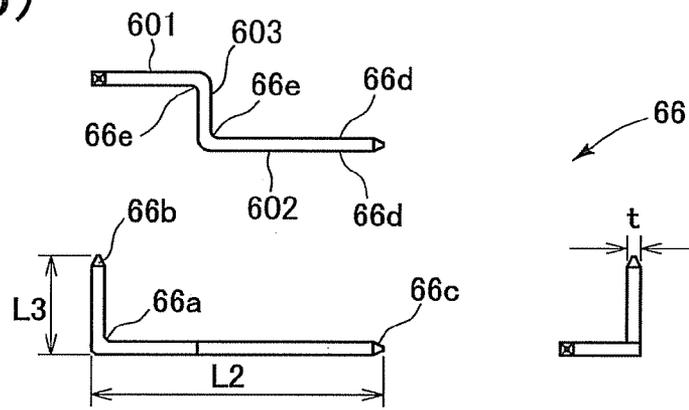


FIG.8(c)

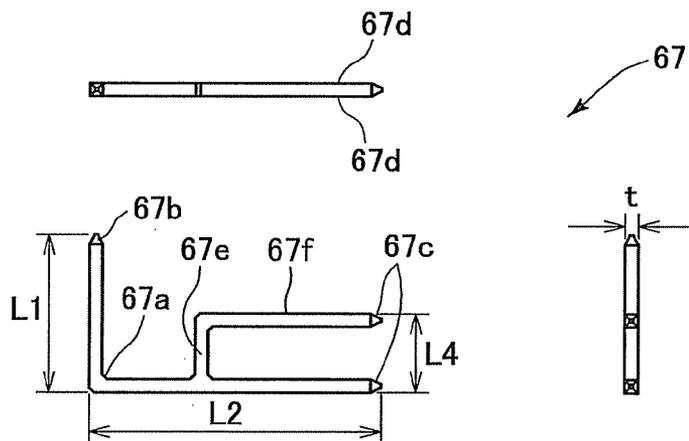


FIG. 9(a)

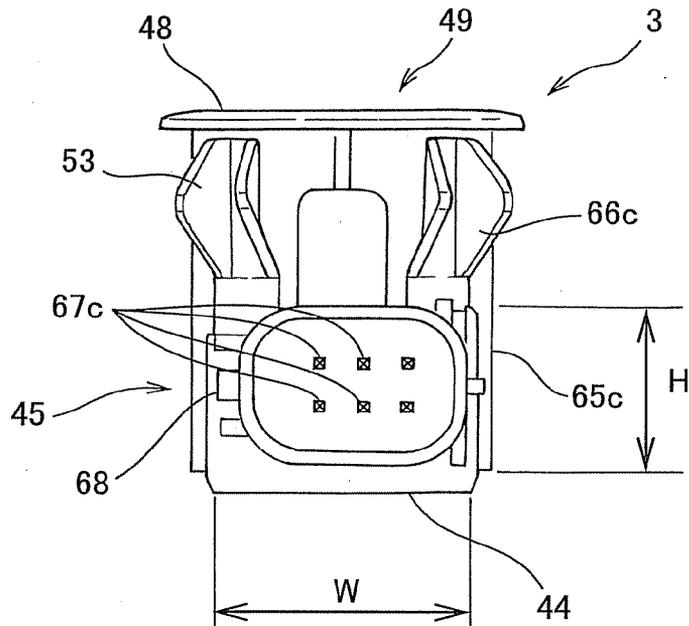


FIG. 9(b)
PRIOR ART

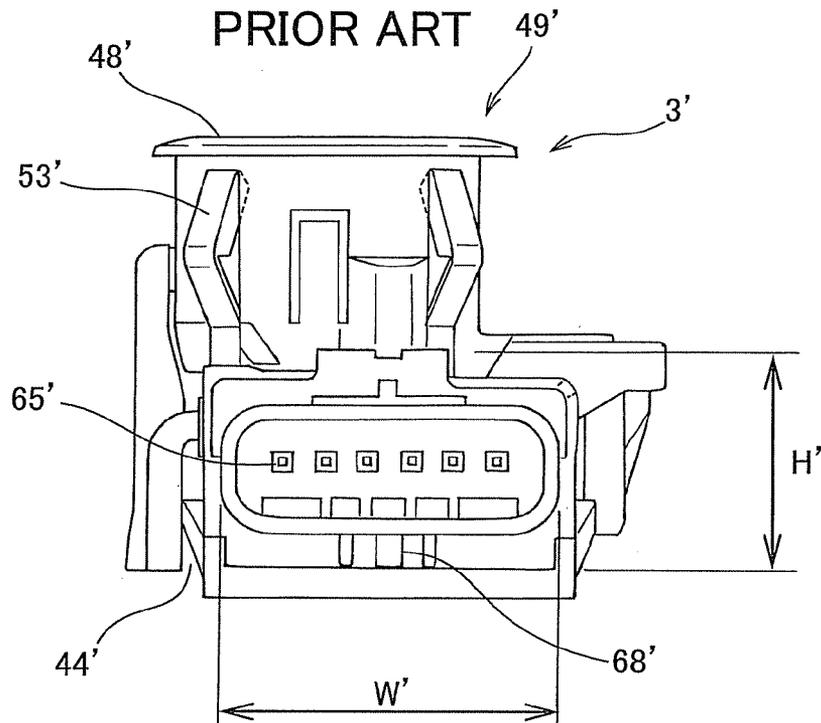


FIG. 10(a)

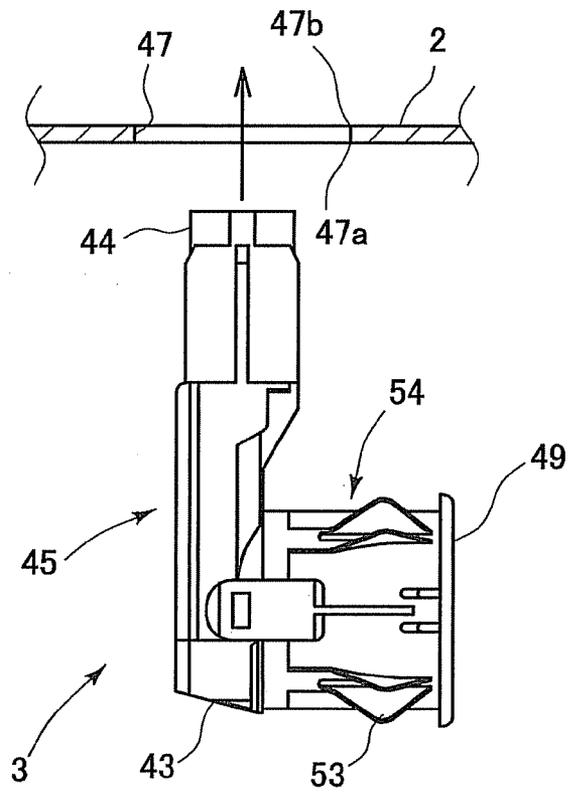


FIG. 10(b)

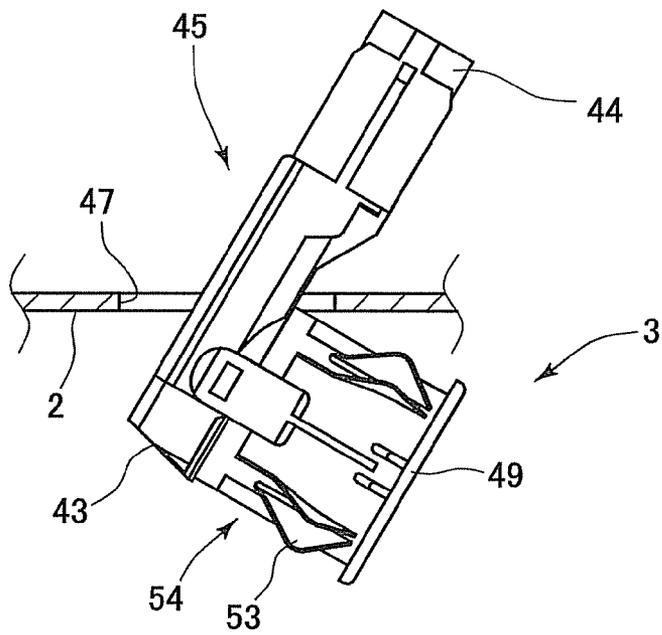


FIG. 11(a)

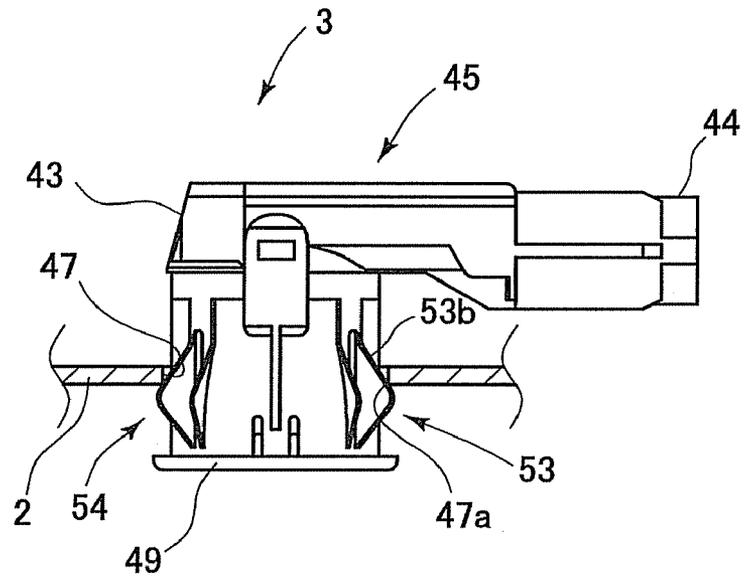


FIG. 11(b)

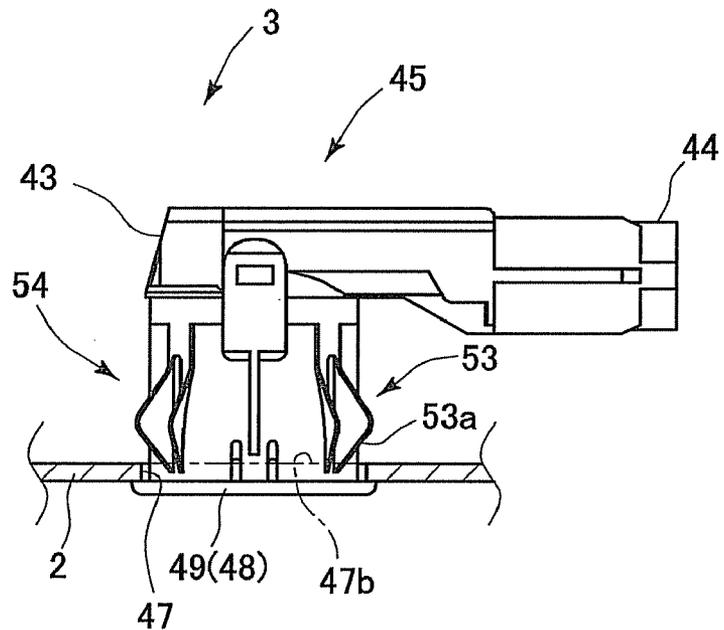
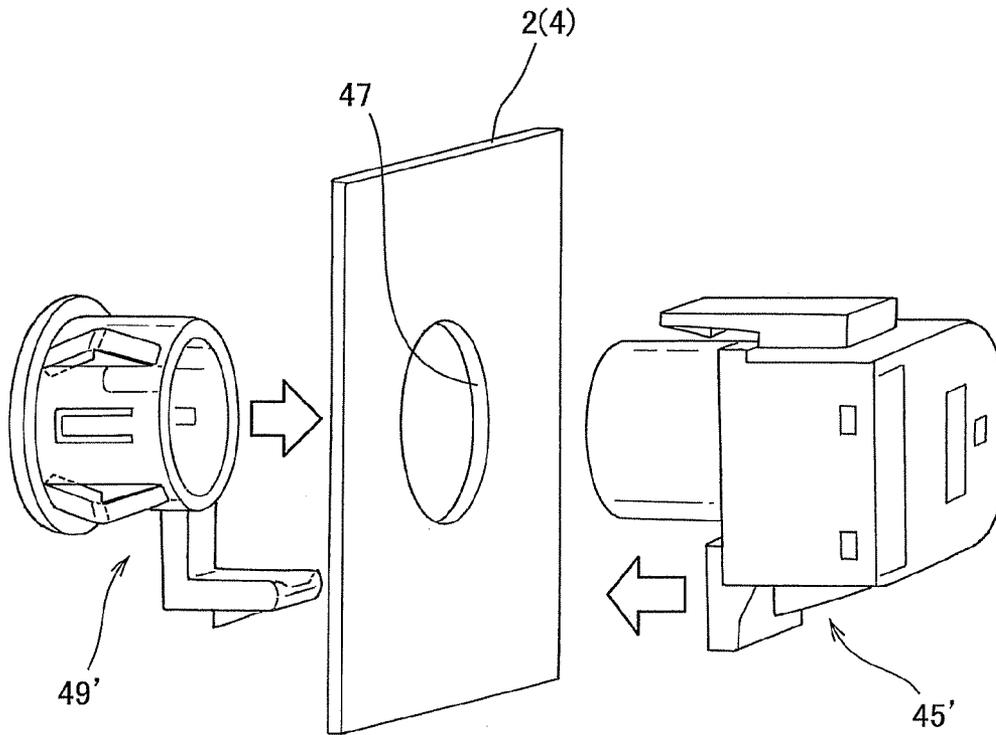


FIG. 12
PRIOR ART



DISTANCE SENSOR FOR VEHICLE WITH ELECTRICAL CONNECTOR

CROSS REFERENCE TO RELATED DOCUMENT

The present application claims the benefits of Japanese Patent Application No. 2010-79488 filed on Mar. 30, 2010, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates generally to an easy-to-install structure of a distance sensor which may be used with an obstacle detection system for vehicles.

2. Background Art

Ultrasonic sensors are known which are used as automotive distance sensors (also called range sensors) which measure the distance between the vehicle and an obstacle using an ultrasonic wave. Some of modern vehicles such as automobiles are equipped with an obstacle detector called a clearance sonar system for assisting the driver in parking the vehicle. The clearance sonar system has a plurality of ultrasonic sensors (e.g., two installed in a front bumper, and four installed in a rear bumper) and works to measure the amount of time required by the ultrasonic wave, as transmitted from each of the ultrasonic sensors, to travel to and return from an obstacle and determine the distance between the vehicle and the obstacle based on the measured amount of time. When such a distance decreases below a given value, the clearance sonar system alerts the driver by sound. For instance, Japanese Translation of PCT Application Publication No. 2000-513296 (corresponding to U.S. Pat. No. 6,227,501 B1) teaches the ultrasonic sensor.

FIG. 12 illustrates a conventional ultrasonic sensor 3' in the installation of the ultrasonic sensor 3' in a mount hole 47 of a bumper 2 is achieved by disassembling the ultrasonic sensor 3' into a bezel 49' and a casing 45', placing the bezel 49' and the casing 45' outside and inside the bumper 2, respectively, and joining them together through the mount hole 47.

The ultrasonic sensor 3' has a plurality of metal springs 53' installed in the bezel 49' in which a sensor device 41' is retained. The metal springs 53' engage a peripheral edge of the mount hole 47 of the bumper 2 to secure the ultrasonic sensor 3' to the bumper 2. The metal springs 53' are made by, for example, a multi-forming machine and then assembled in the bezel 49. Specifically, the installation of the ultrasonic sensor 3' to the bumper 2 requires an additional step of installing the metal springs 53' in the bezel 49', which results in an increase in overall production cost of the ultrasonic sensor 3'.

The joining of the bezel 49' and the casing 45' requires two steps of inserting the bezel 49' into the mount hole 47 of the bumper 2 and then fitting the casing 45' in the bezel 49'. This results in an increase in time consumed to fix the ultrasonic sensor 3' to the bumper 2. If the assembly of the bezel 49' and the casing 45' is inserted into the mount hole 47 of the bumper 2, it may result in plastic deformation of the metal springs 53' when passing through the mount hole 47, which leads to a failure in nipping the wall of the bumper 2 between the bezel 49' and the casing 45'. It is also difficult to use the ultrasonic sensor 3' with bumpers having different thicknesses.

SUMMARY

It is therefore an object to provide an easy-to-install structure of a distance sensor for vehicles.

According to one aspect of an embodiment, there is provided a distance sensor which is to be mounted in a mount hole of a bumper of a vehicle. The distance sensor comprises: (a) a sensor device which works to transmit a signal and receive a return of the signal from an object to determine a distance to the object; (b) a casing with a sensor holder in which the sensor device is held; (c) a bezel including a cylindrical member joined to the sensor holder and a flange formed on one of ends of the cylindrical member which are opposed to each other in an axial direction of the cylindrical member, the flange having an outer diameter greater than an inner diameter of the mount hole; and (d) a resin-made retainer which serves to retain the distance sensor in the bumper. The retainer includes an annular base joined to the bezel, a plurality of arms, and a plurality of protrusions. Each of the arms has a first end and a second end opposite the first end. The arms extend at the first ends from an end of the annular base in the same axial direction of the annular base. The protrusions extend from the second ends of the arms radially outward of the base so that an outer diameter of a circle which is so defined as to pass through outermost tops of the protrusions is greater than the inner diameter of the mount hole. The protrusions are elastically deformed inwardly of the base when the protrusions are forced into the mount hole of the bumper to retain the distance sensor in the bumper and return to original positions thereof when the protrusions have passed through the mount hole. Specifically, when the retainer has passed through the mount hole of the bumper, the protrusions establish a snap-fit on the peripheral edge of the mount hole, thereby nipping a wall of the bumper between the protrusions and the flange of the bezel to secure the distance sensor to the bumper tightly. This structure of the distance sensor eliminates the need for metal springs, as used in the prior art distance sensor discussed above, and facilitates ease of installation of the distance sensor to the bumper of the vehicle.

In the preferred mode of the above structure, each of the protrusions is shaped in the form of a thin wall. Two of the protrusions bulge from an outer periphery of each of the arms in a radially outward direction of the base perpendicular to a lengthwise direction of the arm at a given angular interval away from each other in the form of a V-shape, as viewed from an axial direction of the retainer. Each of the protrusions has a surface which slants at a given angle to the lengthwise direction of the arm and which faces the mount hole when the ultrasonic sensor is mounted in the bumper so as to establish abutting contact with the peripheral edge of the mount hole when the retainer passes through the mount hole. When the retainer passes through the mount hole of the bumper, the slant surfaces of the protrusions placed in abutting contact with the peripheral edge of the mount hole are biased elastically toward a center axis of the retainer so that the circle passing through the outermost tops of the protrusion becomes smaller than the inner diameter of the mount hole of the bumper to permit the protrusions to pass through the mount hole.

Each of the arms has a slit extending in the lengthwise direction thereof to facilitate elastic deformation of the arm.

Each of the arms may be equipped with two of the protrusions. Each of the slits extends between the two of the protrusions. The two of the protrusions bulge radially of the retainer in the form of a V-shape.

Each of the protrusions is shaped to establish the snap fit on the peripheral edge of the mount hole to nip the wall of the bumper between the flange of the bezel and the protrusion when the protrusion has passed through the mount hole.

According to another aspect of the embodiment, there is provided a mount which retains a distance sensor in a mount

hole of a bumper of a vehicle. The mount comprises: (a) a casing with a sensor holder for holding therein a sensor device of the distance sensor which works to transmit a signal and receive a return of the signal from an object to determine a distance to the object; (b) a bezel including a cylindrical member joined to the sensor holder and a flange formed on one of ends of the cylindrical member which are opposed to each other in an axial direction of the cylindrical member, the flange having an outer diameter greater than an inner diameter of the mount hole; and (c) a resin-made retainer which serves to retain the distance sensor in the bumper. The retainer includes an annular base joined to the bezel, a plurality of arms, and a plurality of protrusions. Each of the arms has a first end and a second end opposite the first end. The arms extend at the first ends from an end of the annular base in the same axial direction of the annular base. The protrusions extend from the second ends of the arms radially outward of the base so that an outer diameter of a circle which is so defined as to pass through outermost tops of the protrusions is greater than the inner diameter of the mount hole. The protrusions are elastically deformed inwardly of the base when the protrusions are forced into the mount hole of the bumper to retain the distance sensor in the bumper and returning to original positions thereof when the protrusions have passed the mount hole, thereby establishing a snap-fit on a peripheral edge of the mount hole to nip the wall of the bumper between the protrusions and the flange tightly to secure the distance sensor to the bumper.

In the preferred mode of the above structure, each of the protrusions is shaped in the form of a thin wall. Two of the protrusions bulge from an outer periphery of each of the arms in a radially outward direction of the base perpendicular to a lengthwise direction of the arm at a given angular interval away from each other in the form of a V-shape, as viewed from an axial direction of the retainer. Each of the protrusions has a surface which slants at a given angle to the lengthwise direction of the arm and which faces the mount hole when the ultrasonic sensor is mounted in the bumper so as to establish abutting contact with the peripheral edge of the mount hole when the retainer passes through the mount hole. When the retainer passes through the mount hole of the bumper, the slant surfaces of the protrusions placed in abutting contact with the peripheral edge of the mount hole are biased elastically toward a center axis of the retainer so that the circle passing through the outermost tops of the protrusion becomes smaller than the inner diameter of the mount hole of the bumper to permit the protrusions to pass through the mount hole.

Each of the arms has a slit extending in the lengthwise direction thereof to facilitate elastic deformation of the arm.

Each of the arms may be equipped with two of the protrusions. Each of the slits extends between the two of the protrusions. The two of the protrusions bulge radially of the retainer in the form of a V-shape.

Each of the protrusions is shaped to establish the snap fit on the peripheral edge of the mount hole to nip the wall of the bumper between the flange of the bezel and the protrusion when the protrusion has passed through the mount hole.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood more fully from the detailed description given hereinbelow and from the accompanying drawings of the preferred embodiments of the invention, which, however, should not be taken to limit the invention to the specific embodiments but are for the purpose of explanation and understanding only.

In the drawings:

FIG. 1 is a plan view of an automobile equipped with ultrasonic sensors according to an embodiment;

FIG. 2 is a circuit diagram which illustrates an obstacle detector equipped with the ultrasonic sensors of FIG. 1;

FIG. 3 is a block diagram which illustrates an internal structure of the ultrasonic sensors of FIG. 1 and electrical connections therebetween;

FIG. 4 is a perspective view of the ultrasonic sensor of FIG. 1;

FIG. 5 is an exploded view of the ultrasonic sensor of FIG. 4;

FIG. 6(a) is a plan view which illustrates a retainer of the ultrasonic sensor of FIG. 4;

FIG. 6(b) is a front view of FIG. 6(a);

FIG. 6(c) is a partially enlarged view which illustrates claws of the retainer in FIG. 6(a);

FIG. 7(a) is a perspective view which shows an electrical connector of the ultrasonic sensor of FIG. 4;

FIG. 7(b) is a plan view of FIG. 7(a);

FIG. 8(a) is a three-angled view which shows a terminal pin of the electrical connector of FIGS. 7(a) and 7(b);

FIG. 8(b) is a three-angled view which shows a terminal pin of the electrical connector of FIGS. 7(a) and 7(b);

FIG. 8(c) is a three-angled view which shows a terminal pin of the electrical connector of FIGS. 7(a) and 7(b);

FIG. 9(a) is a front view of an electrical connector of the ultrasonic sensor of FIG. 4;

FIG. 9(b) is a front view of a conventional electrical connector;

FIGS. 10(a) and 10(b) are views which demonstrate steps of installing the ultrasonic sensor of FIG. 4 to a bumper of an automotive vehicle;

FIGS. 11(a) and 11(b) are views which demonstrate steps of installing the ultrasonic sensor of FIG. 4 to a bumper of an automotive vehicle; and

FIG. 12 is a perspective view which shows installation of a conventional ultrasonic sensor to a bumper of an automotive vehicle.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, wherein like reference numbers refer to like parts in several views, particularly to FIG. 1, there is shown an automotive obstacle detector 100 which is implemented by a clearance sonar system. The obstacle detector 100 are equipped with two front ultrasonic sensors 3a and 3b attached to left and right corners of a front bumper 2 of a motor vehicle 1 and three rear ultrasonic sensors 3c, 3d, 3e, and 3f attached to left and right corners and a middle portion of a rear bumper 4. These ultrasonic sensors will also be generally referred to by numeral 3 below. When a given condition is encountered, the ultrasonic sensor 3 is activated to transmit a radar wave in the form of an ultrasonic wave outward of the vehicle 1 and receive a return thereof (i.e., a radar echo) from an obstacle 5 to determine the distance between the vehicle 1 and the obstacle 5. When the distance to the obstacle 5 becomes smaller than a given value, the obstacle detector 100 alerts the driver of the vehicle 1 by sound.

FIG. 2 is a circuit diagram of the obstacle detector 100. In operation, when a main switch 7 of the obstacle detector 100 is placed in an on-state, and an ignition switch 6 is turned on by the driver, electric power is supplied from a battery 12 to a control circuit 11 through a power supply circuit 8. Buzzers 15 and 16 are also placed in a standby state. The buzzer 15 is

connected to the front ultrasonic sensors **3a** and **3b** through a buzzer circuit **13**. Similarly, the buzzer **16** is connected to the rear ultrasonic sensors **3c**, **3d**, **3e**, and **3f** through a buzzer circuit **14**. When the driver places a shift lever of an automatic transmission of the vehicle **1** in a position other than a parking (P) position, a start switch **17** is turned on, so that the obstacle detector **10** starts to operate. When the driver places the shift lever in a reverse (R) position, a backup lamp **18** is turned on to bring only the rear ultrasonic sensors **3c**, **3d**, **3e**, and **3f** into the operable state. The obstacle detector **100** also includes a vehicle speed sensor **19** which measures the speed of the vehicle **1** and is placed in the operable state only when the measured speed of the vehicle is less than, for example, 10 km/h. The obstacle detector **100** is placed in the inoperable state when the parking brake of the vehicle **1** is actuated. A parking brake switch **21** is used to monitor the operating state of the obstacle detector **100**. When the parking brake is actuated, a parking brake lamp **22** is turned on to inform the driver of such a fact. The backup lamp **18**, the vehicle speed sensor **19**, the parking brake switch **21**, and the parking brake lamp **22** are electrically connected to the control circuit **11** through interfaces **23**, **24**, and **25**. Optional peripheral devices associated with the obstacle detector **100** are to be connected to the control circuit **11** through interfaces **26**, **27**, and **28**.

The ultrasonic sensors **3a** to **3f** are, as can be seen in FIGS. **1** and **2**, connected electrically to the ECU **9**. Specifically, the front ultrasonic sensor **3a** mounted in the left corner (i.e., a front passenger side) of the front bumper **2** is connected to a ground (GND) terminal **31a**, a front serial-communication terminal **32a**, and a power supply terminal **33a** through a harness **29a**. The front ultrasonic sensor **3b** mounted in the right corner (i.e., a driver's side) of the front bumper **2** is connected in series with the front ultrasonic sensor **3a** through a harness **29b**. Similarly, the rear ultrasonic sensor **3c** mounted in the left corner of the rear bumper **4** is connected to a ground (GND) terminal **31b**, a rear serial-communication terminal **32b**, and a power supply terminal **33b** through a harness **29c**. The rear ultrasonic sensors **3d**, **3e**, and **3f** mounted in the middle portion and the right corner of the rear bumper **4** are sequentially connected in series with the rear ultrasonic sensor **3c** through harnesses **29d**, **29e**, and **29f**, respectively.

The electric connections between the front ultrasonic sensors **3a** and **3b** mounted in the front bumper **2** will be described below with reference to FIG. **3**.

The front ultrasonic sensors **3a** and **3b** have power supply input (IN) terminals **34a** and **34b** and power supply output (OUT) terminals **35a** and **35b**, respectively. The power supply input terminal **34a** of the ultrasonic sensor **3a** is coupled to the power supply terminal **33a** of the ECU **9**. The power supply output terminal **35a** of the ultrasonic sensor **3a** is coupled to the power supply input terminal **34b** of the ultrasonic sensor **3b** in the form of the daisy chain connection. Each of the ultrasonic sensors **3a** and **3b** is equipped with a power supply circuit made up of a regulator **37** and an FET (Field-Effect Transistor) **38**, and an ASIC (Application Specific Integrated Circuit) **36**. The regulator **37** of the ultrasonic sensor **3a** is disposed between a power supply terminal Vdd of the ASIC **36** and the power supply input terminal **34a**. The FET **38** of the ultrasonic sensor **3a** is disposed among a SW control terminal of the ASIC **36**, the power supply input terminal **34a**, and the power supply output terminal **35a**. Similarly, the regulator **37** of the ultrasonic sensor **3b** is disposed between a power supply terminal Vdd of the ASIC **36** and the power supply input terminal **34b**. The FET **38** of the ultrasonic sensor **3b** is disposed among a SW control terminal of the ASIC **36**, the power supply input terminal **34b**, and the power

supply output terminal **35b**. The FETs **38** work to establish or block the supply of electric power to the ultrasonic sensors **3a** and **3b**.

When it is required to mount an additional ultrasonic sensor in, for example, the front bumper **2**, it is electrically connected, as indicated by broken lines in FIG. **3**, to the ultrasonic sensor **3b**. The rear ultrasonic sensors **3c** to **3f** are connected to one another in the same manner as the front ultrasonic sensors **3a** and **3b**, and explanation thereof in detail will be omitted here. The ultrasonic sensors **3a**, **3b**, **3c**, **3d**, **3e**, and **3f** are identical in structure with each other, and the following discussion will, therefore, be referred to only one of them, as generally indicated by numeral **3**.

The structure of the ultrasonic sensor **3** will be described below with reference to FIGS. **4** and **5**.

The ultrasonic sensor **3** includes a sensor device **41**, a rubber-made cushion **42**, a sensor holder **43**, an electrical connector **44**, a casing **45**, and a bezel **49**. The sensor holder **43**, the connector **44**, the casing **45**, and the bezel **49** are made of resin. The sensor device **41** is of a cylindrical shape and equipped with a microphone which outputs an ultrasonic wave outward of the vehicle **1** and receives a return thereof from an object. The cushion **42** is disposed around the sensor device **41**. The sensor holder **43** holds therein the sensor device **41**. Specifically, the sensor holder **43** retains thereon the cushion **42** in which the sensor device **41** is fit. The electric connector **44** is, as will be described later in detail, designed as a six-pin plug in this embodiment for an electrical connection with a connector (not shown) of one of the harnesses **29a** to **29f**. The casing **45** is formed integrally with the sensor holder **43** and the connector **44**. The connector **44** may alternatively be joined indirectly to the body of the casing **45**. The bezel **49** includes a hollow cylinder **46** fit on the sensor holder **43** of the casing **45** and a flange **48** which extends radially from one of axially-opposed ends of the cylinder **46**. The flange **48**, as illustrated in FIGS. **10(a)** and **10(b)**, has an outer diameter greater than the inner diameter of the mount holes **47** formed in the front and rear bumpers **2** and **4**. The ultrasonic sensor **3** also includes a retainer **54** and a ring **55**. The retainer **54** is used to retain the ultrasonic sensor **3** (i.e., the sensor device **41**) in the bumper **2** or **4**. The retainer **54** has an annular base **51**, arms **52**, and claws **53**. The base **51** is engaged with snap-fit retainer claws **59**, as will be described later in detail, of the bezel **49**. The arms **52** extend from an end of the base **51** in the same axial direction of the base **51**. Each of the claws **53** is configured as a triangular protrusion bulging radially outward of an end of one of the arms **52**. Each of the arms **52** serves as a cantilever snap fit together with the claw **53** to secure the ultrasonic sensor **3** to the bumper **2** or **4** tightly. The ring **55** is disposed in a clearance between an outer periphery of a top portion of the sensor device **41** protruding from an upper end of the cushion **42** and an inner periphery of the cylinder **46** of the bezel **49** when the sensor device **41** is disposed within the cylinder **46** of the bezel **49**.

The cushion **42** has formed on a peripheral surface thereof two half column-shaped protrusions **42a** which are opposed diametrically to each other. The sensor device **41** has two protrusions **41a** which are fit in recesses formed in back surfaces of the protrusions **42a** of the cushion **42** to hold the sensor device **41** from turning within the cushion **42**.

The bezel **49** is, as described above, equipped with the cylinder **46** and the ring-shaped flange **48** extending from the end of the cylinder **46** outwardly. The cylinder **46** has the inner diameter which is slightly greater than the outer diameter of the cushion **42** and is fit on the periphery of the sensor holder **43** of the casing **45**. The cylinder **46** has snap-fit tabs **56**, half pipe-like protrusions **58**, and the retainer claws **59**

formed on the outer periphery thereof. The snap-fit tabs 56 extend in an axial direction of the cylinder 46 and engage claws 57 of the casing 45 to establish a firm joint between the bezel 49 and the casing 45. The protrusions 58 protrude from the outer periphery of the cylinder 46 and are fit on bulges 43a of the sensor holder 43 together with the protrusions 42a of the cushion 42. The retainer claws 59 protrude from the cylinder 46 and are snap-fit on the base 51 of the retainer 54. The bulges 43a of the sensor holder 43 extend vertically of the sensor holder 43 and are of an U-shape in cross section. In other words, each of the bulges 43a has an U-shaped groove formed in an inner wall of the sensor holder 43. Each of the bulges 43a may alternatively be designed to have an inner surface lying flush with the inner surface of the sensor holder 43. Each of the protrusions 41a of the sensor device 41 is fit in the inside recess of a corresponding one of the protrusions 42a of the cushion 42. Each of the protrusions 42a of the cushion 42 is placed on an upper end of a corresponding one of the bulges 43a of the sensor holder 43. Each of the protrusions 58 of the bezel 49 is fit over, in other words, covers a corresponding one of the bulges 43a in contact therewith, thereby positioning or holding the cushion 42 along with the sensor device 41 from turning in the circumferential direction of the sensor holder 43. The upper end of each of the protrusions 42a placed on the bulge 43a in vertical alignment therewith is in abutment with an inner upper end of the protrusion 58, in other words, each of the protrusions 42a is nipped between the inner upper end of the protrusion 58 and the bulge 43a tightly, thereby positioning the cushion 42 along with the sensor device 41 relative to the sensor holder 43.

The retainer 54 has, as described above, the tuning-fork like four arms 52 extending from the end of the base 52 upward, as viewed in FIGS. 4, 5, and 6(b), in the axial direction of the retainer 54. Each of the arms 52 has the two claws 53 formed on the top end thereof. Each of the claws 53 extends from an upper end of a main body of one of the arms 52. Each of the claws 53 is shaped in the form of a thin wall and serves as a thin-walled hook. The two claws 53 of each of the arms 52 bulge from an outer periphery of the arm 52 in a radially outward direction of the base 52 perpendicular to the axial direction or lengthwise direction of the arm 52, as clearly illustrated in FIG. 6(a), in the form of a V-shape, as viewed from the axial direction of the retainer 54. The outer diameter of an imaginary circle C, as passing through outermost tops of the claws 53, is set greater than the inner diameter of the mount hole 47. The angle θ , as illustrated in FIG. 6(c), which inside faces of the two claws 53 of each of the arms 52 make with each other is preferably within a range of 70° to 90°. Each of the claws 53 is substantially triangular in shape, as viewed from a direction perpendicular to the axis of the retainer 54, and has, as clearly illustrated in FIG. 6(b), upper and lower ridges with slant surfaces 53a and 53b. Specifically, the ridge of each of the claws 53 is tapered upward and downward in the axial direction of the arm 52 to have the slant surfaces 53a and 53b. The slant surface 53a faces upward, as viewed in the drawing, while the slant surface 53b faces downward. Each of the arms 52 has a central vertical slit 61 which extends through the middle of the width thereof, as viewed in a circumferential direction of the retainer 54. In other words, the slit 61 extends in a lengthwise direction of the arm 52 between the claws 53 to the annular base 51 of the retainer 54, thereby forming the claws 53 to be separate completely from each other at bases thereof (i.e., lower ends of the claws 53). The annular base 51 has, as clearly illustrated in FIG. 6(c), formed in an inner circumference thereof recesses defining thin-walled portions 63 near the lower ends of the slits 61. When the retainer 54 is inserted

into one of the mount holes 47 of the front and rear bumpers 2 and 4, the claws 53 of each of the arms 52 are elastically deformed or bent at the bases thereof in directions, as indicated by 62 in FIG. 6(c), toward the axis (i.e., the center) of the retainer 54. The slit 61 and the thin-walled portion 61 facilitate the ease of the elastic deformation of the claws 53.

The annular base 51 of the retainer 54 has formed in the bottom thereof recesses 64 to achieve snap-fits with the retainer claws 59 of the bezel 49. Specifically, each of the claws 59 engages a corresponding one of the recesses 64 to establish a firm joint between the bezel 49 and the retainer 54. This minimizes the transmission of stress to the casing 45 when the ultrasonic sensor 3 is installed in the mount hole 47, thereby decreasing the possibility of damage to the casing 45.

The casing 45 has, as described above, the hollow cylindrical sensor holder 43 which retains therein the sensor device 41 fit in the cushion 42. The sensor holder 43 has formed thereon the bulges 43a on which the protrusions 42a of the cushion 42 are placed. The hooks 58 of the bezel 49 engage the bulges 43a of the sensor holder 43, thereby holding the cushion 42 from rotating relative to the sensor holder 43. The sensor holder 43 has formed on a lower portion thereof the claws 57 which create snap-fits with the snap-fit tubs 56 of the bezel 49.

The casing 45 has the connector 44 which has a given length extending horizontally. The connector 44 extends from a side surface of the sensor holder 43 perpendicular to the axis of the sensor holder 43.

The structure of the electrical connector 44 will be described below in detail with reference to FIGS. 7(a) to 8(c).

The connector 44 is engineered as a multi-pin plug equipped with a plurality of terminal pins 65 to 67 (a total of four pins in this embodiment). The terminal pins 65 to 67 are made of conductive strips for electrical connections with holes of the connector of one of the harnesses 29a to 29f. In this embodiment, the connector 44 is designed as a six-pin plug using the four terminal pins 65 to 67. The terminal pins 65 to 67 are insert-molded with the resinous casing 45. The terminal pins 65 to 67 are bent, as clearly illustrated in FIGS. 8(a) to 8(c) at middle portions 65a, 66a, and 67a thereof to have a substantially L-shaped length. The two terminal pins 65 and 66 are, as can be seen from FIGS. 8(a) and 8(b), different in shape from each other and will also be referred to as first terminal pins below. The first terminal pin 65 has an upright section 65b and a horizontal section 65c. The first terminal pin 66 has an upright section 66b and a horizontal section 66c. The upright sections 65b and 66b of the first terminal pins 65 and 66, as can be seen in FIG. 8(a), extend through a shell of the connector 44 downward, as viewed in FIGS. 5 and 8(a), and connect with a sensor control circuit board (not shown) on which the regulator 37, the EFT 38, the ASIC 36, etc., as already described in FIG. 3, are fabricated. The sensor control circuit board is disposed on or in the bottom of the connector 44 (i.e., the casing 45). The sensor device 41 is also joined electrically to the sensor control circuit board within the casing 45. The horizontal sections 65c and 66c of the first terminal pins 65 and 66 extend parallel to the length of the connector 44 within the shell of the connector 44 toward an opening 48 of the connector 44 for electrical connections with one of the harnesses 29a to 29f. The sections 65c and 66c are used as the input and output terminals 34a and 35a (or 34b and 35b), as illustrated in FIG. 3, to and from electric power is inputted and outputted.

The two terminal pins 67 are identical in shape with each other and will also be referred to as second terminal pins below. The second terminal pins 67 are, as illustrated in FIG. 3, used as the ground (GND) and serial-communication ter-

minals of the ultrasonic sensor 3. Each of the second terminal pins 67, as illustrated in FIG. 8(c), has an upright section 67b and two horizontal sections 67c which are so formed as to have a lower-case "h" shape. The section 67b of each of the second terminal pins 67, like the upright sections 65b and 66b of the first terminal pins 65 and 66, extends through the shell of the connector 45 and connects electrically with the sensor control circuit board, while the horizontal sections 67c extend parallel to the length of the connector 44 toward the opening 48 of the connector 44 for electrical connections with one of the harnesses 29a to 29f. The sections 65b, 66b and 67b (which will also be referred to as first sections below) extend substantially parallel to each other on the same plane. The sections 65c, 66c, and 67c (which will also be referred to as second sections below) extend perpendicular to the sections 65b, 66b, and 67b in this embodiment, but may extend so as to traverse the lengths of the sections 65b, 66b, and 67b, respectively, at an angle other than 90°.

The first terminal pin 65 is, as illustrated in FIG. 8(a), bent at right angles into an L-shape which is made up of the upright and horizontal sections 65b and 65c with tapered tips. The first terminal pin 65 is made by punching a metal plate which is already folded into an L-shape in cross section and has a thickness t using a press. The direction in which the first terminal pin 65 is punched out from the L-shaped metal plate is indicated by "P" in FIG. 8(a). The first terminal pin 65, therefore, has punched side surfaces 65d which extend perpendicular to the direction P and have a fine roughness. The side surfaces 65d serve as electric contacts with the connector of one of the harnesses 29a to 29f. The length of the upright section 65b of the first terminal pin 65 is expressed by L1, and that of the horizontal section 65c is expressed by L2. The same applies, as indicated in FIGS. 8(b) and 8(c), to the pin terminals 66 and 67.

The first terminal pin 66 is, as can be seen from FIG. 8(b), bent into a crank-shape. The sections of the first terminal pin 66, as suffixed with the same characters as in FIG. 8(a), are identical in structural function with those of the first terminal pin 65. The first terminal pin 66 is made by punching a metal plate which is already folded into an L-shape and has a thickness t to form an L-shaped strip similar in shape to the first terminal pin 65 and then bending the L-shaped strip, as can be seen in FIG. 8(b), twice horizontally at portions 66e at right angles into a crank-shape, thereby completing the first terminal pin 66. Specifically, the first terminal pin 66 has the L-shape made up of the upright and horizontal sections 66b and 66c. The horizontal section 66c is folded into the crank-shape on a plane extending perpendicular to the length of the upright section 66b to form three sections 601, 602, and 603. The length L3 of the upright section 66b (i.e., the height of the second terminal pin 66) that is the distance between the tip of the upright section 66b and the bend 66a is smaller than the length L1 of the upright section 65b of the first terminal pin 65. The length L2 of the horizontal section 66c (i.e., the distance between the bend 66a and the tip of the horizontal section 66c) is identical with the length L2 of the horizontal section 65c of the first terminal pin 65. The section 601 extends substantially parallel to the section 602. The section 603 extends perpendicular to the sections 601 and 602. The section 602 is located away from the section 601 in a direction parallel to the section 603 by the length of the section 603, so that the section 602 extends, as illustrated in FIG. 8(a), over and parallel to the horizontal section 65c of the first terminal pin 65 within the shell of the connector 44.

The second terminal pins 67 are, as described above, identical in structure with each other. The sections of the second terminal pin 67, as suffixed with the same characters as in

FIGS. 8(a) and 8(b), are identical in structural function with those of the first terminal pins 65 and 66. Specifically, the second terminal pin 67 is bent at right angles at a portion 67a to form the upright section 67b and the branched horizontal sections 67c. A lower one of the two horizontal sections 67c, as viewed in FIG. 8(c), will also be referred to as a lower section below, while an upper one of the horizontal sections 67c will also be referred to as an upper section below. The lower section 67c is identical in shape with the horizontal section 65c of the first terminal pin 65. The upper section 67c diverges from a middle portion of the length of the lower section 67c and serves as a branch conductive terminal. The upper section 67c is made up of an upright section 67e and a horizontal section 67f extending substantially perpendicular to the upright section 67e. The upright section 67e extends substantially parallel to the upright section 67b. The horizontal section 67f extends substantially parallel to the lower section 67c. The upper and lower sections 67c, as can be seen in FIG. 7(a), serve as branch conductive pins and lay on a plane extending through the upright section 67b. The second terminal pin 67 is, as is clear from the above, designed as a two-pin terminal.

The length L1 of the upright section 67b is identical with that of the upright section 65b of the first terminal pin 65. The length L4 of the upright section 67e that is the interval between the upper and lower sections 67c is equal to the length L1 minus the length L3 of the upright section 66b of the first terminal pin 66 (i.e., $L4=L1-L3$).

The length L2 of the lower section 67c of the second terminal pin 67 is identical with those of the horizontal sections 65c and 66c of the first terminal pins 65 and 66. As described above, the upright sections 65a, 66b, and 67b of the first and second terminal pins 65, 66, and 67, as illustrated in FIG. 7(a), pass vertically through the shell of the connector 44 (i.e., the bottom wall of the casing 45) and are arrayed to be flush with each other on a plane extending substantially perpendicular to the length of the connector 44 (i.e., parallel to the axis of the sensor holder 43). The horizontal sections 65c and 67c of the first and second terminal pins 65 and 67 extend horizontally to be flush with each other on a plane extending substantially parallel to the length of the connector 44. Similarly, the upper sections 67f of the second terminal pins 67 and the horizontal section 66c of the first terminal pin 66 extend horizontally to be flush with each other on a plane extending substantially parallel to the length of the connector 44.

The connector 44 is made by resin, for example, using the injection molding techniques. The terminal pins 65, 66, and 67 are insert-molded with the connector 44.

The ultrasonic sensor 3 of this embodiment and the prior art ultrasonic sensor 3' will be compared below with reference to FIGS. 9(a) and 9(b). The components of the prior art ultrasonic sensor 3' corresponding to those of the ultrasonic sensor 3 are denoted by the same reference numbers suffixed with "'". The bezel 49' of the prior art ultrasonic sensor 3', as illustrated in FIG. 9(b), is equipped with a metal spring 53'. The metal spring 53' has one end secured to the ultrasonic sensor 3' and the other end which is to be stretched when the ultrasonic sensor 3' is inserted into the mount hole 47 of the bumper 2 or 4. The stretching of the other end of the metal spring 53' may result in plastic deformation of the metal spring 53'.

The ultrasonic sensor 3 of this embodiment includes the retainer 54 made of resin that is an elastically deformable material. The retainer 54, as described above, has the arms 52 with the claws 53. When the ultrasonic sensor 3 is inserted into the mount hole of the bumper 2 or 4, the arms 52 are deformed along with the claws 53 toward the longitudinal

center line of the retainer 54 (i.e., the center of the annular base 52). Each of the claws 53 is shaped like a resinous thin plate and is, therefore, hardly subjected to the plastic deformation and requires a little pressure to mount the ultrasonic sensor 3 in the bumper 2 or 4.

The connector 44' of the prior art ultrasonic sensor 3' is an in-line six-pin plug with six terminal pins 65' arrayed horizontally in line, thus resulting in an increase in width W'. Each of the terminal pins 65' has upper and lower surfaces as electric contacts with a socket of a mating connector and is, thus, equipped with upper and lower lances 68' for achieving a firm joint with the mating connector. This results in an increase in height H' of the connector 44 including the lances.

The ultrasonic sensor 3 of this embodiment is, as can be seen from FIG. 9(a), designed as a two-line six-pin plug equipped with two arrays each of which has three contact pins. Specifically, the ultrasonic sensor 3 includes the four terminal pins 65, 66, and 67 which are arrayed and shaped to have six contact pins arranged in a grid pattern. In other words, the ends of the six contact pins (i.e., sections 65c, 66c, and 67c) lie on intersections of vertical and horizontal lines of the grid pattern, as viewed from the opening 48 of the connector 44 in the lengthwise direction (i.e., the axial direction) of the connector 44. Each of the terminal pins 65, 66, and 67 has the side surfaces that are to establish electrical contacts with the socket of one of the harnesses 29a to 29f, thus permitting, as illustrated in FIG. 9(a), the side walls of the connector 44 to have lances 68 without the need for increasing the width W of the connector 44. The lances 68 are formed on the side walls of the connector 44, thus not increasing the height H of the connector 44. This facilitates the ease of inserting the connector 44 into the mount hole 47 of the bumper 2 or 4.

The installation of the ultrasonic sensor 3 in the mount hole 47 of, for example, the bumper 2 will be described below with reference to FIGS. 10(a) to 11(b). The structural components (especially, the bezel 49, the retainer 54, and the casing 45) of the ultrasonic sensor 3 other than the sensor device 41, as will be apparent from the above discussion, constitutes a mount for securing the ultrasonic sensor 3 in the mount hole 47 of the bumper 2 or 4.

The ultrasonic sensor 3 into which the sensor device 41, the bezel 49, the retainer 54, the casing 45, etc., are assembled is, as illustrated in FIG. 10(a), inserted at the connector 44 into the mount hole 47 of the bumper 2. The connector 44 of the ultrasonic sensor 3 is, as described above, designed as a six-pin plug using the four terminal pins 65 to 67 and, thus, as illustrated in FIGS. 9(a) and 9(b), has the width W and the height H smaller than the width W' and the height H' of the conventional ultrasonic sensor 3', respectively, thus facilitating the ease of insertion of the connector 44 into the mount hole 47.

When the connector 44 of the casing 45, as illustrated in FIG. 10(b), has passed through the mount hole 47 of the bumper 2, the ultrasonic sensor 3 is tilted and rotated to insert the sensor holder 43 through the mount hole 47 until the annular base 51 of the retainer 54 passes through the mount hole 47, and the slant surfaces 53b of the claws 53 of the retainer 54, as illustrated in FIG. 11(a), hit an outside inner edge 47a of the mount hole 47. Subsequently, the ultrasonic sensor 3 is pushed to thrust the claws 53 into the mount hole 47, thus causing the arms 52 to be elastically deformed inwardly of the annular base 51, that is, the slant surfaces 53b to be biased toward the center axis of the retainer 54, as indicated by the arrows 62 in FIG. 6(c), to permit the claws 53a to pass through the mount hole 47. The slits 61 formed in the arms 52 and the thin-walled portions 63 of the annular

base 51 facilitate the elastic deformation of the arms 52 and the passage of the claws 53a through the mount hole 47. The elastic deformation of the arms 52 results in a decreased diameter of the circle C, as illustrated in FIG. 6(a), passing through outermost tops of the claws 53, so that it becomes smaller than the inner diameter of the mount hole 47, thereby permitting the retainer 54 to pass through the mount hole 47. The surfaces 53b of the ridges of the claws 53 are, as described above, inclined relative to the longitudinal center line of the retainer 54 (i.e., the direction in which the bezel 49 and the retainer 54 are inserted into the mount hole 47), thus facilitating the insertion of the ultrasonic sensor 3 through the mount hole 47.

When the outermost tops of the claws 53 have passed through an inside inner edge 47b of the mount hole 47, as illustrated in FIG. 11(b), the slant surfaces 53a of the ridges of the claws 53 slide inwardly of the mount hole 47 along the inside inner edge 47b, so that the claws 53 (i.e., the arms 52) expand elastically outward in directions opposite the directions C in FIG. 6(c). When the flange 48 of the bezel 49 hit against the outside surface of the bumper 2 around the mount hole 47, the claws 53 recover and return to original positions thereof, so that the slant surfaces 53a of the claws 53, as indicated by a broken line in FIG. 11(b), are placed in abutting contact with the inside inner edge 47b of the mount hole 47, in other words, establish snap-fits on the inner edge 47b, thereby nipping the wall of the bumper 2 tightly between the slant surfaces 53a of the claws 53 of the retainer 54 and the flange 48 of the bezel 49. The ridges of the claws 53 of the retainer 54 which are closer to the flange 49 (i.e., the surfaces 53a of the claws 53) are inclined inwardly from outside to inside the mount hole 47 of the bumper 2. Consequently, the elasticity of the claws 53 and the arms 52 serve to hold the wall of the bumper 2 between the surfaces 53a of the claws 53 and the inside surface of the flange 47 tightly. This absorbs an error of thickness of the bumper 2 and achieves the tight fit of the ultrasonic sensor 3 in the mount hole 47. The removability of the ultrasonic sensor 3 from the mount hole 47 of the bumper 2 is achieved by pulling the bezel 49 outward in the axial direction of the retainer 54 to elastically contract the claws 53 inward of the retainer 54.

As apparent from the above discussion, the installation or removal of the ultrasonic sensor 3 into or from the mount hole 47 is accomplished easier than the conventional ultrasonic sensor 3'. The connection of one of the harnesses 29a to 29f to the ultrasonic sensor 3 may be achieved by passing the connector (not shown) of the one of the harnesses 29a to 29f from inside to outside the mount hole 47 of the bumper 2, joining the connector 44 of the ultrasonic sensor 3 to the connector of the one of the harnesses 29a to 29f outside the bumper 2, and fitting the ultrasonic sensor 3 into the mount hole 47 in the manner, as described above.

The casing 45, the sensor holder 43, and the connector 44 of the ultrasonic sensor 3 may alternatively be formed as discrete members.

The bezel 48 and the connector 44 of the casing 45 are so oriented as to have lengths thereof extending perpendicular to each other, but may alternatively be made to have the lengths traversing each other at a given angle other than 90°.

The above described structure may also be used with range sensors using optical or electromagnetic devices other than ultrasonic devices.

The ultrasonic sensor 3 may be installed in vehicles other than wheeled vehicles.

The first terminal pins 65 and 66 of each of the ultrasonic sensors 3 are, as described above, used as a power supply input terminal and a power supply output terminal, but how-

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ever, alternatively be designed as signal input and output terminals into and from which signals inputted from and outputted to the ECU 9.

The ultrasonic sensor 3 may also be designed to have at least one of the first terminal pins 65 and 66 and at least one of the second terminal pins 67. Either one of the second terminal pins 67 may have at least two branched pins (i.e., the second sections 67c.

While the present invention has been disclosed in terms of the preferred embodiment in order to facilitate better understanding thereof, it should be appreciated that the invention can be embodied in various ways without departing from the principle of the invention. Therefore, the invention should be understood to include all possible embodiments and modifications to the shown embodiment which can be embodied without departing from the principle of the invention as set forth in the appended claims.

What is claimed is:

1. A distance sensor for a vehicle which is to be inserted and mounted in a mount hole of a bumper of a vehicle to measure a distance between the vehicle and an obstacle, the distance sensor comprising:

a sensor body which transmits a signal outside the vehicle and receives a signal being reflected and returned from the obstacle;

a case body with a sensor holding portion which holds the sensor body;

a bezel including a cylindrical portion engaging the sensor holding portion of the case body and a flange formed on an end of the cylindrical portion in an axial direction thereof, the flange having a diameter greater than an inner diameter of the mount hole of the bumper; and

a retainer which includes a ring-shaped base engaging the bezel, a plurality of arms extending from an end surface of the base in an axial direction along an axis of the base, and claws protruding from top portions of the arms in a radius direction of the arms so that an outer diameter of a circle passing through tops of the claws is greater than an inner diameter of the mount hole of the bumper, the claws shrinking when inserted into the mount hole of the bumper and returning elastically to original positions of the claws when the claws have passed the mount hole, thereby engaging an inner edge on an exit side of the mount hole.

2. A distance sensor for a vehicle as set forth in claim 1, wherein the claws are made of a pair of thin plates which

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protrude from an outer peripheral surface of the arms in a direction intersecting with the axis and are oriented at a given angle away from each other to have a V-shape as viewed from an axial direction of the retainer, the claws having a slant surface, as viewed in a direction perpendicular to the axis of the retainer, formed on a portion thereof which is to be first inserted into the mount hole of the bumper and to be placed in contact with an inner peripheral edge on an entrance side of the mount hole; and

when the claws of the retainer are inserted into the mount hole of the bumper, the slant surfaces approach the axis of the retainer, so that the outer diameter of the circle passing through the tops of the claws decreases to be smaller than the inner diameter of the mount hole of the bumper.

3. A distance sensor for a vehicle as set forth in claim 2, wherein the arms of the retainer have a slit extending from a top end to a base end of the retainer in the axial direction of the retainer for facilitating elastic deformation of the claws.

4. A vehicle distance sensor mount structure for mounting a distance sensor, as set forth in claim 3, in a bumper of a vehicle, wherein the case body of the distance sensor is inserted into the mount hole of the bumper from outside the bumper, the claws of the retainer are engaged with the inner peripheral edge on the exit side of the mount hole and the bumper is grasped by the flanges of the bezel and the claws.

5. A vehicle distance sensor mount structure for mounting a distance sensor, as set forth in claim 2, in a bumper of a vehicle, wherein the case body of the distance sensor is inserted into the mount hole of the bumper from outside the bumper, the claws of the retainer are engaged with the inner peripheral edge on the exit side of the mount hole and the bumper is grasped by the flanges of the bezel and the claws.

6. A distance sensor for a vehicle as set forth in claim 1, wherein the arms of the retainer have a slit extending from a top end to a base end of the retainer in an axial direction of the retainer for facilitating elastic deformation of the claws.

7. A vehicle distance sensor mount structure for mounting a distance sensor, as set forth in claim 1, in a bumper of a vehicle, wherein the case body of the distance sensor is inserted into the mount hole of the bumper from outside the bumper, the claws of the retainer are engaged with the inner peripheral edge on the exit side of the mount hole and the bumper is grasped by the flanges of the bezel and the claws.

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